From: Khoury, Ghassan
Sent: Thursday, August 25, 2016 9:41 AM
To: Kirk, Andrea; Berg, Marlene; Turner, Philip; Miller, Garyg
Cc: Burgess, Michele; Legare, Amy; Poore, Christine; Villarreal, Chris; Banipal, Ben; Sanchez, Carlos; Meyer, John
Subject: FW: PRG for Sediment at San Jacinto River
Attachments: Risk from Exposure to Sediment and Fish.docx; Pages from Volume I Draft Final BHHRA Report_17May2013.pdf; Pages from Volume II_Draft_Final_BHHRA Report_Appendices_ 17May2013.pdf

Hi Andrea, I sent you the report on how the region developed a sediment cleanup level of 30 ppt in a report on August 17, 2016 12:10 pm. It is still draft and accepting any comments you may have. In table 2 of the report, I provided concentration of fish I used in calculating the risk. Note that the cleanup level is associated with a HI of one, regardless of what are the measured concentrations in fish at the fish collection areas (FCA). I am also attaching a figure for the location of the FCAs and areas where fish were caught. Also an attachment of the concentrations of fish/shellfish we used in the risk calculations. Hope this is helpful.

From: Khoury, Ghassan
Sent: Wednesday, August 17, 2016 12:10 PM
To: Berg, Marlene <Berg.Marlene@epa.gov>; Kirk, Andrea <Kirk.Andrea@epa.gov>
Cc: Banipal, Ben <banipal.ben@epa.gov>; Villarreal, Chris <villarreal.chris@epa.gov>; Khoury, Ghassan <Khoury.Ghassan@epa.gov>
Subject: PRG for Sediment at San Jacinto River

Hi Marlene and Andrea,

Attached is the risk analysis for exposure to sediment and fish/shellfish and the PRG associated with such exposures. If you need further clarification please don't hesitate to email me or call me at 214-665-8515.

Ghassan A. Khoury MSPH, Sc.D.

Risk and Site Assessment Technical Section
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August 05, 2016

MEMORANDUM

SUBJECT: Human Health Risk Evaluation and Recommended Sediment Cleanup Level for Site Specific Exposure to Sediment at the San Jacinto River Superfund Site.

FROM: Ghassan A. Khoury, MSPH, Sc.D.

Risk and Site Assessment Technical Section (6SF-TR)

TO: Gary Miller, RPM

AR/TX Section (6SF-RA)

I evaluated the risk from exposure to sediment and ingestion of fish contaminated with dioxin by a child recreational fisher at the San Jacinto River Site. A sediment cleanup level was also developed. Review comments received from reviewers were incorporated in this report. The following are the methods and procedures I followed:

Summary:

The risk to a recreational child fisher from exposure to sediment through the ingestion and dermal routes of intake was calculated for Beach Area E at a hazard quotient (HQ) of 63.4 which is greater than the EPA acceptable level of a HQ of one. The other Beach Areas (Beach Area A, B/C, and D) had levels lower than the EPA acceptable HQ of one (see table 1). The risk to a recreational child fisher from ingestion of fish and shellfish at fish collection area (FCA) 1 and combined fish collection areas 2 and 3 (FCA 2/3) was calculated at a HQ of 1.8 which is higher than the EPA acceptable level of a HQ of one. Most of the risk was due to ingestion of Hardhead catfish fillet. Ingestion of shellfish was found acceptable if ingested at the rate used in the calculations (600 mg/day). The preliminary remediation goal (PRG) calculated for fish tissue is 3.1E-06 mg/Kg and for shellfish is 7.3E-05 mg/Kg.

The total PRG from exposure to sediment through the ingestion of sediment, dermal contact with the sediment, ingestion of finfish, and ingestion of shellfish is calculated at 2.89E-05 mg/Kg or 28.9 ng/Kg rounded up to 30 ng/Kg.

Introduction/Background:

The San Jacinto River Waste Pits Superfund site includes several impoundments that were used in the mid-1960s for the disposal of paper mill wastes. The northern impoundments consist of two impoundments, together occupying approximately 14 acres, and are located on a 20-acre parcel north of the I-10 Bridge on the western bank of the San Jacinto River. Historical documents and aerial photographs suggest that in the mid-1960s an additional impoundment (i.e., the southern impoundment) was constructed on a peninsula of land south of I-10 and may have been used for the disposal of paper mill waste.

The site is located in Channelview, a suburb of Houston in Harris County, Texas. There are a number of surrounding communities from which individuals might come to visit the Site. The closest surrounding communities are Highlands and Baytown. A conservative exposure scenario to protect the most vulnerable members of a community is considered. It is assumed that a hypothetical recreational child fisher get exposed to dioxin in sediment through the ingestion of fish, shellfish, dermal contact with and ingestion of sediment. The following are details of the risk evaluation.

Risk and PRG Analysis from Exposure to dioxin in Sediment through the Ingestion and Dermal Contact Routes of Intake

In this evaluation non-cancer risk and PRG are calculated based on EPA's tier 1 non-cancer oral reference dose (RfD) toxicity value. It is expected that clean up levels developed based on the non-cancer RfD will not need additional cleanup when a new EPA cancer toxicity value for dioxin is published in EPA's integrated Risk Information System (IRIS). This is because dioxin cleanup levels based on the tier 1 IRIS RfD are within the cancer risk range if tier 3 Cal EPA cancer toxicity value or EPA old cancer toxicity value or slope factors are used.

Risk and PRG Estimates from Sediment Ingestion:

The risk to a hypothetical recreational child fisher is assumed in this risk evaluation. Risk to a child was found more conservative than exposure to adult or a combined adult and child exposure. If we assume the same exposure frequency and ingestion rate of

39 days/year (USFWS, 2006; Ebert et al. 1998) and 125 mg/day (US EPA, 2011) respectively as used in the Baseline Human Health risk assessment (Integral, 2013) for the site, then the HQ for Beach Area E is calculated at 16.5 which exceeds the EPA acceptable level of HQ=1. The PRG is calculated at 7.86E-04 mg/Kg. The HQs for all other sampled Beach Areas were below EPA's acceptable HQ level of 1 (check table 1 below).

$$HQ = \frac{C_S\left(\frac{mg}{Kg}\right) * IRS_c\left(125\,\frac{mg}{day}\right) * EF_r\left(39\,\frac{days}{yr}\right) * ED_r(6\ yr) * (10^{-6}\,\frac{Kg}{mg})}{ATn\ (6\ years) * \left(\frac{365days}{year}\right) * BWc(15\ Kg) * \frac{RfDo}{RBA}}$$

Where:

Sediment Concentration (Site Specific)		Cs	1.30E-02*	mg/Kg
Exposure Frequency Recreational Fisher Child		EFr	39	days/Year
Exposure Duration Recreational Fisher Child		EDr	6	Years
Sediment Ingestion Rate Recreational Fisher Child		IRSc	125	mg/day
Conversion Factor		CF	0.000001	Kg/mg
Averaging Time Recreation Fisher Child Non-Cancer		ATn	6*365	days
Averaging Time Recreational Fisher Child Cancer		Atc	70*365	days
Life Time		LT	70	Years
Body Weight Recreational Fisher Child		BWc	15	Kg
Relative Bioavailability		RBA	1	unitless
Oral Reference Dose		RfDo	7.00E-10	mg/Kg day
Hazard Quotient		HQ	1	Unitless
Risk-Noncacer		PRG		
HQ =	1.65E+01	Sediment	7.86E-04	mg/Kg
* Includes dioxin-like PCBs of 4.50E-06 mg/Kg				

Risk from Dermal Exposure to Sediment:

The risk to a hypothetical recreational child fisher is assumed in this risk evaluation. Risk to a child was found more conservative than exposure to adult or a combined adult and child exposure. If we assume the same exposure frequency of 39 days/year and a skin surface area of 3280 cm^2 (includes child's hands, arms, feet and surface area of the whole legs) as used in the BHHRA for San Jancinto River site (Integral, 2013). A

sediment adherence factor of 3.6 mg/cm^2 (US EPA, 2011) and a chemical specific dermal absorption factor of 0.03 (US EPA, 2004) is also used. Then the HQ is calculated at 46.9 which exceeds the EPA acceptable level of HQ=1. The PRG is calculated at 2.77E-04 mg/Kg. The HQs for all other sampled Beach Areas were below EPA's acceptable HQ level of 1 (check table 1 below).

$$HQ = \frac{C_S\left(\frac{mg}{Kg}\right) * SAc\left(3280\frac{cm2}{day}\right) * EF_c\left(39\frac{day}{yr}\right) * EDc\ (6\ years) * AF\ \left(3.6\frac{mg}{cm2}\right) * \left(10^{-6}\frac{Kg}{mg}\right) * ABS_d/GIABS_o}{AT\ (6\ years) * \left(\frac{365days}{year}\right) * BW\ (15\ Kg) * RfDo}$$

Where:

Sediment Concentration (Site Specific)	Cs	1.30E-02*	mg/Kg
Exposure Frequency Recreational Fisher Child	EFc	39	days/Year
Exposure Duration Recreational Fisher Child	EDc	6	Years
Sediment Skin Surface Area-Recreational Fisher Child	SAc	3280	cm2
Adherence Factor Recreational Fisher Child	AF c	3.6	mg/cm2
Conversion Factor	CF	0.000001	Kg/mg
Averaging Time Recreational Fisher Child NonCancer	ATn	6*365	days
Averaging Time Recreational Fisher Child Cancer	Atc	70*365	days
Life Time Exposure	LT	70	Years
Body Weight Recreational Fisher Child	BWc	15	Kg
Dermal Absorption	ABSd	0.03	unitless
Gastro-intestinal Absorption	GIABSo	1	Unitless
Oral Reference Dose	RfDo	7.00E-10	mg/Kg day
Hazard Quotient	HQ	1	Unitless
Risk-Noncacer		PRG	
HQ =	4.69E+01	Sediment	2.77E-04 mg/Kg
*Include dioxin-like PCBs of 4.50E-06 mg/Kg.			

Fish/Shellfish Ingestion

Risk from Fish/Shellfish Ingestion:

The risk to a hypothetical recreational child fisher is assumed in this risk evaluation. Risk to a child was found more conservative than exposure to adult or a combined adult and child exposure. Hardhead catfish was used as representative of exposure to all finfish and clam/crab tissues as representative of all shellfish tissues. Hardhead catfish are benthic feeders. Therefore using Hardhead catfish to represent risk from ingestion

of other finfish is a conservative assumption. The annualized average daily fish ingestion rate of 14 grams/day for a young child was adopted from the Lavaca Bay study (ALCOA, 1998). The Lavaca Bay study included surveys from nearly 2,000 anglers from Texas who participated in the study. The exposure frequency is 350 days/year (365 days/year – 15 days/year) since the ingestion rate is an annualized daily average and it is assumed that residents take 15 days per year away from their residential areas. A default contaminated fraction ingested of 25 percent (0.25) of all fish consumed comes from the site. The non-cancer risk or HQ for a child consuming dioxin contaminated fish caught from FCA 1 and FCA 2/3 Areas of the site are calculated at 1.8 which are higher than the EPA acceptable level of a HQ = 1. The same procedure is followed for other areas of the site. Most of the risk was due to ingestion of Hardhead catfish fillet. Ingestion of shellfish was found acceptable if ingested at the rate used in the calculations (600 mg/day) which was adopted from Lavaca Bay Study (ALCOA,1998). The PRG calculated for fish tissue is 3.1E-06 mg/Kg and for shellfish is 7.3E-05 mg/Kg (See table 2 below).

Fish Ingestion Equation:

$$HQ = \frac{C_{fish}\left(\frac{mg}{Kg}\right) * IRF_c\left(14000\,\frac{mg}{day}\right) * EF_c\left(350\,\frac{days}{yr}\right) * ED_c(6\,yr) * \left(10^{-6}\,\frac{Kg}{mg}\right) * FC(0.25)}{ATn\,(6\,years) * \left(\frac{365days}{year}\right) * BWc(15\,Kg) * RfDo\,(\frac{mg}{Kg-day})}$$

Where:

Fish Tissue Concentration (Site Specific)	Cfish	5.63E-06*	mg/Kg
Exposure Frequency Recreational Fisher Child	EFc	350	days/Year
Exposure Duration Recreational Fisher Child	EDc	6	Years
Fish Ingestion Rate Recreational Fisher Child	IRFc	14000	mg/day
Conversion Factor	CF	0.000001	Kg/mg
Averaging Time Recreational Fisher Child NonCancer	ATn	6*365	days
LifeTime	LT	70	Years
Body Weight Recreation Child fisher	BW c	15	Kg
Fraction Ingested from Contaminated site	FC	0.25	unitless
Oral Reference Dose	RfDo	7.00E-10	mg/Kg day
HQ		1	Unitless
Risk	PRG		

HQ =	1.80E+00	Fish Ingestion	3.13E-06	mg/Kg

Subsistence fishing was evaluated in the risk assessment. Individuals involved in subsistence fishing is expected to have higher risk from ingestion of fish or shellfish than the recreational fisher. However, true subsistence fishing was not observed and is not expected at the site (Integral, 2013) and therefore cleanup level was based on recreational fisher child.

Total Sediment PRG

To calculate a sediment PRG for human protection from ingestion of contaminated fish, a biota-sediment accumulation factor (BSAF) is required that correlates sediment concentration to fish tissue concentration. The Texas Environmental Health Institute supported a study done by Baylor's Center for Reservoir and Aquatic Systems Research (Sascha Usenko, et al., 2012) to understand bioaccumulation of dioxin and furans at the San Jacinto River Waste Pits site. In their report, they developed a site specific BSAF value for fish of 0.044 pg/g tissue per pg/g sediment. However, they point out that the method used for developing BSAF value for fish inherently lead to somewhat lower BSAFs values than may have been observed elsewhere. A review of published BSAF values developed for fish ranges from 0.00065 to 0.32 (Sascha Usenko, et al., 2012; Bukhard, L.P. et al. 2004; USACE, 2016). The US EPA Combustion guidance (USEPA, 2005) provides a BSAF value of 0.09 for 2,3,7,8-TCDD in fish. Therefore based on the Baylor's study which expects a site specific BSAF estimates greater than 0.044 and based on EPA Combustion guidance and other published BSAF values, we decided to adopt EPA's Combustion Guidance BSAF value of 0.09 pg/g tissue per pg/g sediment in calculating the sediment PRG value.

$$Sediment_{fish}PRG = \frac{Fish\ PRG}{BSAF}$$

The sediment PRG for fish consumption is estimated to be 3.47E-05 mg/Kg (3.1E-06 / 0.09) or 35 ng/Kg.

The total PRG from exposure to sediment through the ingestion of sediment, dermal contact with the sediment, ingestion of catfish, and ingestion of shellfish is calculated at 2.89E-05 mg/Kg or 28.9 ng/Kg rounded up to 30 ng/Kg.

Conclusions and Recommendations:

The risk to a hypothetical child fisher from exposure to sediment through the ingestion and dermal routes of intake is calculated for Beach Area E at a HQ of 63.4 which is greater than the EPA acceptable level of a HQ of one. The other Beach Areas (Beach Area A, B/C, and D) have very low HQ, much lower than the EPA acceptable HQ of one (see table 1 below).The PRG for the sediment is calculated at 2.05E-04 mg/Kg through the ingestion and dermal routes of intake (see table 1 below). The risk to a hypothetical child fisher from ingestion of fish and shellfish is calculated at a HQ of 1.8 which is higher than the EPA acceptable level of a HQ of one. Most of the risk was due to ingestion of Hardhead catfish fillet. Ingestion of shellfish was found acceptable if ingested at the rate used in the calculations (600 mg/day). The PRG calculated for fish tissue is 3.1E-06 mg/Kg and for shellfish is 7.3E-05 mg/Kg. The total sediment PRG for contact with sediment through the ingestion and dermal routes of intake plus ingestion of fish and shellfish is calculated at 30 ng/Kg.

Table 1: Risk evaluation from exposure to sediment in different locations of the site. Exposure of a child to sediment through the ingestion and dermal contact was evaluated based on a recreational fisher exposure scenario.*

Media/Route	Beach Area A			Beach Area B/C			Beach Area D			Beach Area E		
	RME (mg/Kg)	HQ**	PRG (mg/Kg)	RME (mg/Kg)	HQ	PRG (mg/Kg)	RME (mg/Kg)	HQ	PRG (mg/Kg)	RME (mg/Kg)	HQ	PRG (mg/Kg)
Sediment/ Ingestion	4.56E-07	5.8E-04	7.9E-04	6.36E-06	8.1E-03	7.9E-04	2.12E-06	2.7E-03	7.9E-04	1.30E-02	16.5	7.9E-04
Sediment/ Dermal	4.56E-07	1.64E-03	2.77E-04	6.36E-06	2.29E-02	2.77E-04	2.12E-06	7.64E-03	2.77E-04	1.30E-02	46.9	2.77E-04
Total		2.22E-03	2.05E-04		3.1E-02	2.05E-04		1.0E-02	2.05E-04		63.4	2.05E-04

***Recreational fisher child exposure scenarios and input parameters similar to the numbers used in the Baseline Human Health Risk Assessment (Integral, 2013) were used here too. Sediment Dioxin Background level was found at 6.07E-07 mg/Kg and dioxin like PCBs at 1.98E-07 mg/Kg for a total of 8.1E-07 mg/Kg.**

****Highlighted Numbers are for HQ > 1**

Table 2: Risk evaluation from ingestion of fish/shellfish in different locations of the site. A child is assumed to consume fish/Shellfish based on a recreational fisher exposure scenario.

Media/Route	FCA 1			FCA 2/3			FCA 1/3			FCA 2			Background
	RME (mg/Kg)	HQ	PRG (mg/Kg)	RME (mg/Kg)	HQ	PRG (mg/Kg)	RME (mg/Kg)	HQ	PRG (mg/Kg)	RME (mg/Kg)	HQ	PRG (mg/Kg)	RME (mg/Kg)
Hardhead Catfish Fillet/ Ingestion	3.92E-06+ 1.67E-06* =5.59E-06	1.79	3.13E-06	4.06E-06 +1.57E-06 =5.63E-06	1.8	3.13E-06							1.65E-06 +1.65E-06 =3.3E-06
Edible Clam Tissue/Ingestion							1.65E-06 +1.67E-06 =3.32E-06	4.6E-02	7.3E-05	1.90E-05 +8.24E-07 =1.98E-05	2.7E-01	7.3E-05	4.70E-07 +2.12E-07 =6.82E-07
Edible Crab Tissue/Ingestion	1.07E-06 +1.48E-07 =1.22E-06	1.67E-02	7.3E-05	2.86E-07 +2.96E-07 =5.82E-07	8E-03	7.3E-05							1.83E-07 +9.44E-08 =2.77E-07
Total		1.80			1.8			4.6E-02			2.7E-01		

*Dioxin-like PCBs

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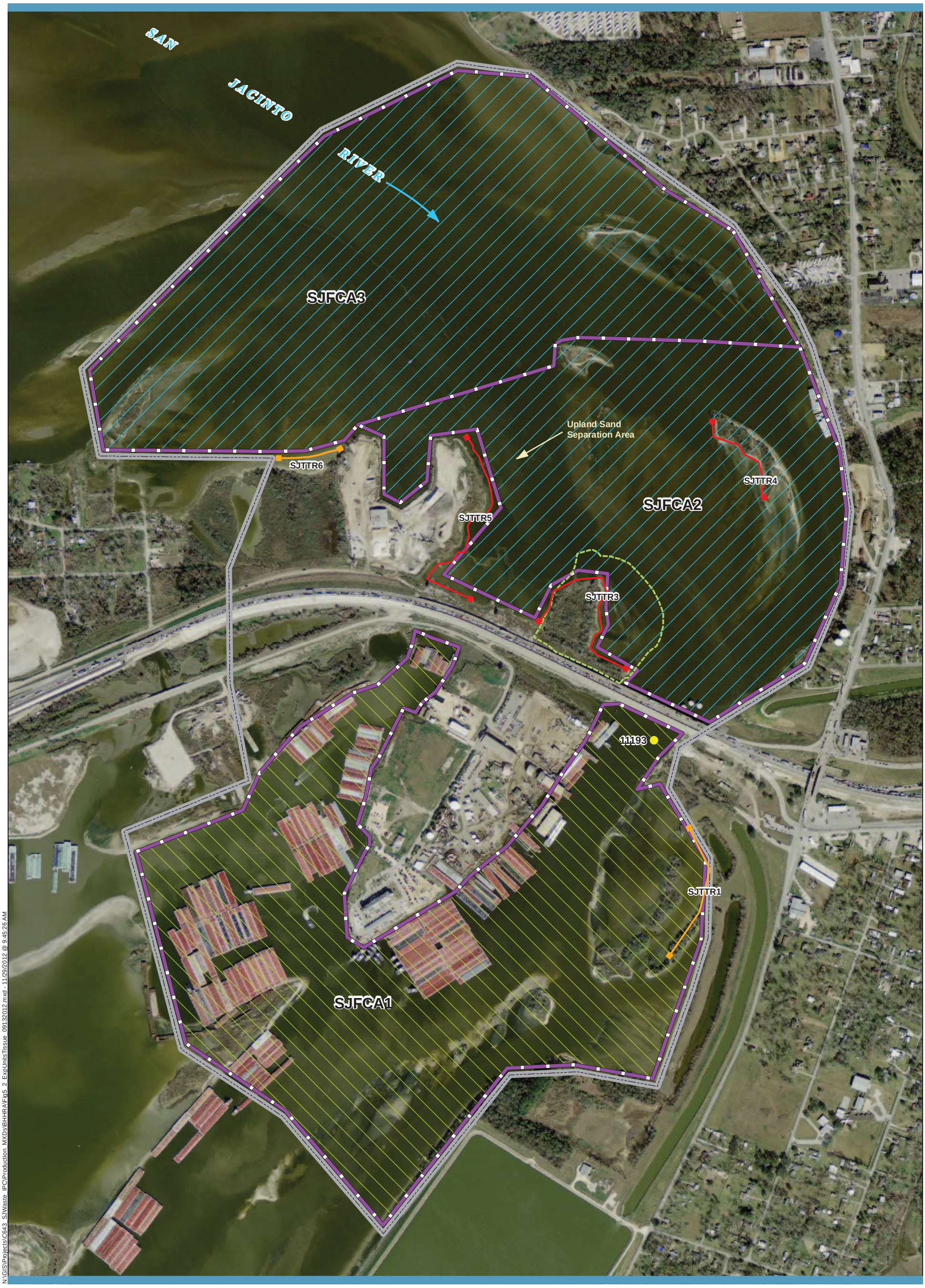

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Feet

- Large Fish Collection Location (University of Houston and Parsons, 2009)
- Large Fish and Blue Crab Fish Collection Area
- Hardhead Catfish Fillet and Blue Crab Exposure Unit: "FCA 1"
- Hardhead Catfish Fillet and Blue Crab Exposure Unit: "FCA 2/3"
- Clam Exposure Unit: "FCA 1/3"
- Clam Exposure Unit: "FCA 2"
- Original 1966 Perimeter of the Impoundments North of I-10
- USEPA's Preliminary Site Perimeter

Figure 5-2
Exposure Units for Fish and Shellfish Tissue, Area North of I-10 and Aquatic Environment
Baseline Human Health Risk Assessment
San Jacinto River Waste Pits Superfund Site

Table E-2

Exposure Point Concentrations for Tissue, Baseline Conditions

Tissue Type	Exposure Unit	$COPC_H$	Units[a]	Number of Samples	Detection Frequency (percent)	Minimum Detection Limit	Maximum Detection Limit	Distribution Type	Method	Mean[b,c]	95UCL[d]	Maximum[c,d]
Hardhead Catfish Fillet	FCA 1	**Dioxins and Furans**										
		TEQ_{DF} (ND = 1/2DL)	ng/kg	10	100	--	--	normal	ucl.t	2.94	3.92	5.45
		TEQ_{DF} (ND = DL0)	ng/kg	10	100	--	--	normal	ucl.t	2.88	3.86	5.32
		Metals										
		Arsenic	mg/kg	10	100	--	--	normal	ucl.t	0.484	0.564	0.698
		Cadmium	mg/kg	10	20	0.001	0.0011	unknown	ucl.proucl.np	0.000925	0.00238	0.0039
		Chromium	mg/kg	10	50	0.02	0.02	unknown	ucl.proucl.np	0.033	0.0926	0.14
		Copper	mg/kg	10	100	--	--	lognormal	ucl.cheb.log	0.344	0.509	0.612
		Mercury	mg/kg	10	100	--	--	normal	ucl.t	0.159	0.19	0.266
		Nickel	mg/kg	10	100	--	--	lognormal	ucl.cheb.log	0.027	0.0612	0.076
		Zinc	mg/kg	10	100	--	--	lognormal	ucl.cheb.log	19.8	29.4	39.7
		Polychlorinated Biphenyls										
		Sum of 43 PCB Congeners (ND = 1/2DL)	ng/kg	12	100	--	--	normal	ucl.t	84800	104000	156000
		Sum of 43 PCB Congeners (ND = DL0)	ng/kg	12	100	--	--	normal	ucl.t	84800	104000	156000
		TEQ_P (ND = 1/2DL)	ng/kg	12	100	--	--	normal	ucl.t	1.38	1.67	2.27
		TEQ_P (ND = DL0)	ng/kg	12	100	--	--	normal	ucl.t	1.04	1.43	2.17
		Semivolatile Organic Compounds										
		Bis(2-ethylhexyl)phthalate	µg/kg	10	0	210	210	all below DL	max	105	105	105
	FCA 2/3	**Dioxins and Furans**										
		TEQ_{DF} (ND = 1/2DL)	ng/kg	20	100	--	--	normal	ucl.t	3.58	4.06	5.85
		TEQ_{DF} (ND = DL0)	ng/kg	20	100	--	--	normal	ucl.t	3.51	3.99	5.84
		Metals										
		Arsenic	mg/kg	20	100	--	--	lognormal	ucl.cheb.log	0.389	0.665	1.42
		Cadmium	mg/kg	20	10	0.001	0.0013	unknown	ucl.proucl.np	0.000678	0.00103	0.002
		Chromium[e]	mg/kg	20	40	0.02	0.02	unknown	ucl.proucl.np	0.027	0.0347	0.08
		Copper	mg/kg	20	100	--	--	normal	ucl.t	0.265	0.28	0.381
		Mercury	mg/kg	20	100	--	--	lognormal	ucl.cheb.log	0.0908	0.143	0.264
		Nickel	mg/kg	20	95	0.013	0.013	lognormal	ucl.cheb.log	0.0186	0.032	0.064
		Zinc	mg/kg	20	100	--	--	normal	ucl.t	16.4	18	26.2
		Polychlorinated Biphenyls										
		Sum of 43 PCB Congeners (ND = 1/2DL)	ng/kg	20	100	--	--	normal	ucl.t	83000	94200	129000
		Sum of 43 PCB Congeners (ND = DL0)	ng/kg	20	100	--	--	normal	ucl.t	83000	94200	129000
		TEQ_P (ND = 1/2DL)	ng/kg	20	100	--	--	normal	ucl.t	1.32	1.57	2.79
		TEQ_P (ND = DL0)	ng/kg	20	100	--	--	lognormal	ucl.cheb.log	0.696	2.38	2.7
		Semivolatile Organic Compounds										
		Bis(2-ethylhexyl)phthalate	µg/kg	20	0	210	210	all below DL	max	105	105	105

Table E-2

Exposure Point Concentrations for Tissue, Baseline Conditions

Tissue Type	Exposure Unit	$COPC_H$	Units[a]	Number of Samples	Detection Frequency (percent)	Minimum Detection Limit	Maximum Detection Limit	Distribution Type	Method	Mean[b,c]	95UCL[d]	Maximum[c,d]
Edible Clam	FCA 1/3	**Dioxins and Furans**										
		TEQ_{DF} (ND = 1/2DL)	ng/kg	10	100	--	--	normal	ucl.t	1.27	1.65	2.19
		TEQ_{DF} (ND = DL0)	ng/kg	10	100	--	--	normal	ucl.t	1.09	1.51	2.12
		Metals										
		Arsenic	mg/kg	10	100	--	--	normal	ucl.t	0.491	0.523	0.604
		Cadmium	mg/kg	10	100	--	--	normal	ucl.t	0.0253	0.0268	0.0297
		Chromium	mg/kg	10	100	--	--	normal	ucl.t	0.169	0.201	0.29
		Copper	mg/kg	10	100	--	--	lognormal	ucl.cheb.log	2.29	3.37	3.37
		Mercury	mg/kg	10	100	--	--	normal	ucl.t	0.0111	0.0128	0.0178
		Nickel	mg/kg	10	100	--	--	normal	ucl.t	1.39	1.58	1.87
		Zinc	mg/kg	10	100	--	--	normal	ucl.t	9.74	10.6	12.7
		Polychlorinated Biphenyls										
		Sum of 43 PCB Congeners (ND = 1/2DL)	ng/kg	10	100	--	--	normal	ucl.t	19300	21700	26900
		Sum of 43 PCB Congeners (ND = DL0)	ng/kg	10	100	--	--	normal	ucl.t	19200	21600	26900
		TEQ_P (ND = 1/2DL)	ng/kg	10	100	--	--	normal	ucl.t	0.293	0.346	0.436
		TEQ_P (ND = DL0)	ng/kg	10	100	--	--	normal	ucl.t	0.066	0.0802	0.104
		Semivolatile Organic Compounds										
		Bis(2-ethylhexyl)phthalate	µg/kg	10	0	210	210	all below DL	max	105	105	105
	FCA 2	**Dioxins and Furans**										
		TEQ_{DF} (ND = 1/2DL)	ng/kg	15	100	--	--	lognormal	ucl.cheb.log	4.42	19	27
		TEQ_{DF} (ND = DL0)	ng/kg	15	100	--	--	lognormal	ucl.cheb.log	3.91	21.4	26.9
		Metals										
		Arsenic	mg/kg	15	100	--	--	normal	ucl.t	0.546	0.586	0.741
		Cadmium	mg/kg	15	100	--	--	normal	ucl.t	0.0274	0.0294	0.0351
		Chromium	mg/kg	15	100	--	--	lognormal	ucl.cheb.log	0.159	0.221	0.295
		Copper	mg/kg	15	100	--	--	lognormal	ucl.cheb.log	2.63	4.02	4.8
		Mercury	mg/kg	15	86.7	0.0088	0.0091	normal	ucl.t	0.00961	0.0114	0.0154
		Nickel	mg/kg	15	100	--	--	normal	ucl.t	1.18	1.3	1.6
		Zinc	mg/kg	15	100	--	--	normal	ucl.t	10.8	11.4	14
		Polychlorinated Biphenyls										
		Sum of 43 PCB Congeners (ND = 1/2DL)	ng/kg	15	100	--	--	lognormal	ucl.cheb.log	26000	50000	61800
		Sum of 43 PCB Congeners (ND = DL0)	ng/kg	15	100	--	--	lognormal	ucl.cheb.log	26000	50000	61800
		TEQ_P (ND = 1/2DL)	ng/kg	15	100	--	--	lognormal	ucl.cheb.log	0.41	0.824	1.9
		TEQ_P (ND = DL0)	ng/kg	15	100	--	--	lognormal	ucl.cheb.log	0.142	0.442	0.787
		Semivolatile Organic Compounds										
		Bis(2-ethylhexyl)phthalate	µg/kg	15	0	210	210	all below DL	max	105	105	105

Table E-2

Exposure Point Concentrations for Tissue, Baseline Conditions

Tissue Type	Exposure Unit	$COPC_H$	Units[a]	Number of Samples	Detection Frequency (percent)	Minimum Detection Limit	Maximum Detection Limit	Distribution Type	Method	Mean[b,c]	95UCL[d]	Maximum[c,d]
Edible Crab	FCA 1	**Dioxins/Furans**										
		TEQ_{DF} (ND = 1/2DL)	ng/kg	10	100	--	--	normal	ucl.t	0.739	1.07	1.91
		TEQ_{DF} (ND = DL0)	ng/kg	10	100	--	--	normal	ucl.t	0.599	0.972	1.85
		Metals										
		Arsenic	mg/kg	10	100	--	--	normal	ucl.t	0.466	0.521	0.646
		Cadmium	mg/kg	10	100	--	--	lognormal	ucl.cheb.log	0.0148	0.0244	0.0276
		Chromium	mg/kg	10	90	0.02	0.02	normal	ucl.t	0.047	0.0629	0.1
		Copper	mg/kg	10	100	--	--	lognormal	ucl.cheb.log	11.1	13.8	16.2
		Mercury	mg/kg	10	100	--	--	normal	ucl.t	0.0527	0.0577	0.0652
		Nickel	mg/kg	10	0	0.057	0.108	all below DL	max	0.042	0.054	0.054
		Zinc	mg/kg	10	100	--	--	normal	ucl.t	50.4	51.6	54.7
		Polychlorinated Biphenyls										
		Sum of 43 PCB Congeners (ND = 1/2DL)	ng/kg	10	100	--	--	lognormal	ucl.cheb.log	1160	3350	4820
		Sum of 43 PCB Congeners (ND = DL0)	ng/kg	10	100	--	--	lognormal	ucl.cheb.log	1080	3290	4740
		TEQ_P (ND = 1/2DL)	ng/kg	10	100	--	--	normal	ucl.t	0.119	0.148	0.234
		TEQ_P (ND = DL0)	ng/kg	10	100	--	--	lognormal	ucl.cheb.log	0.00649	0.0201	0.0271
		Semivolatile Organic Compounds										
		Bis(2-ethylhexyl)phthalate	µg/kg	10	0	210	210	all below DL	max	105	105	105
	FCA 2/3	**Dioxins/Furans**										
		TEQ_{DF} (ND = 1/2DL)	ng/kg	20	60	0.164	0.376	lognormal	ucl.cheb.log	0.164	0.286	0.558
		TEQ_{DF} (ND = DL0)	ng/kg	20	60	0.164	0.376	unknown	ucl.proucl.np	0.0617	0.176	0.523
		Metals										
		Arsenic	mg/kg	20	100	--	--	normal	ucl.t	0.426	0.459	0.596
		Cadmium	mg/kg	20	100	--	--	lognormal	ucl.cheb.log	0.0103	0.0201	0.0494
		Chromium[f]	mg/kg	20	40	0.02	0.08	lognormal	ucl.cheb.log	0.00981	0.0261	0.09
		Copper	mg/kg	20	100	--	--	normal	ucl.t	10.4	11.1	15.4
		Mercury	mg/kg	20	100	--	--	normal	ucl.t	0.0339	0.0379	0.0522
		Nickel	mg/kg	20	0	0.043	0.135	all below DL	max	0.0348	0.0675	0.0675
		Zinc	mg/kg	20	100	--	--	normal	ucl.t	47.6	50	59.1
		Polychlorinated Biphenyls										
		Sum of 43 PCB Congeners (ND = 1/2DL)	ng/kg	20	100	--	--	lognormal	ucl.cheb.log	4710	7170	11400
		Sum of 43 PCB Congeners (ND = DL0)	ng/kg	20	100	--	--	lognormal	ucl.cheb.log	4660	7130	11300
		TEQ_P (ND = 1/2DL)	ng/kg	20	100	--	--	lognormal	ucl.cheb.log	0.165	0.296	0.547
		TEQ_P (ND = DL0)	ng/kg	20	100	--	--	unknown	ucl.proucl.np	0.0665	0.186	0.525
		Semivolatile Organic Compounds										
		Bis(2-ethylhexyl)phthalate	µg/kg	20	0	210	210	all below DL	max	105	105	105

Table E-2

Exposure Point Concentrations for Tissue, Baseline Conditions

Tissue Type	Exposure Unit	$COPC_H$	Units[a]	Number of Samples	Detection Frequency (percent)	Minimum Detection Limit	Maximum Detection Limit	Distribution Type	Method	Mean[b,c]	95UCL[d]	Maximum[c,d]

Reference

USEPA, 2010. ProUCL Version 4.1.00 technical guide. EPA/600/R-07/041. U.S. Environmental Protection Agency, Washington, DC. May.

Notes

-- = not applicable

95UCL = 95 percent upper confidence limit

$COPC_H$ = chemical of potential concern for human health

DL = detection limit

FCA = fish collection area

max = the maximum value was selected as the UCL in instances where the detection frequency was 0

ND = 1/2DL = nondetect set at one-half the detection limit

ND = DL0 = nondetect set at zero

PCB = polychlorinated biphenyl

TEQ_{DF} = toxicity equivalent for dioxins and furans

TEQ_P = toxicity equivalent for dioxin-like polychlorinated biphenyls

UCL = upper confidence limit on the mean

ucl.t = UCL for normally distributed data, calculated based on the T statistic

ucl.cheb.log = UCL for lognormally distributed data, using a chebyshev correction factor

ucl.proucl.np = nonparametric UCL for an unknown data distribution, same method as ProUCL (USEPA 2010)

a - All concentrations are on a wet weight basis unless the units indicate otherwise.

b - Means are determined as appropriate for the distribution of the data. The mean value is the central tendency exposure point concentration.

c - In line with the data treatment rules defined for this project, nondetected values were treated as one-half the DL in determining the mean and maximum concentrations. Exceptions are noted with DL0. In these cases nondetected concentrations were treated as 0.

d- The lower of the UCL and maximum will be used as the reasonable maximum exposure point concentration.

e - Because the detection frequency was between 20 and 50%, N ≥ 10, and the distribution type was unknown, Kaplan Meier estimator was used for calculating the UCL.

f - Because the detection frequency was between 20 and 50%, N ≥ 10, and the distribution type was lognormal, regression on order statistics (a method for substituting for nondetects) was used for calculating the UCL.